

FERMILAB E791 *

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Abstract

Fermilab E791, a very high statistics charm particle experiment, recently completed its data taking at Fermilab's Tagged Photon Laboratory. Over 20 billion events were recorded through a loose transverse energy trigger and written to 8mm tape in the the 1991-92 fixed target run at Fermilab. This unprecedented data sample containing charm is being analysed on many-thousand MIP RISC computing farms set up at sites in the collaboration. A glimpse of the data taking and analysis effort is presented. We also show some preliminary results for common charm decay modes. Our present analysis indicates a very rich yield of over 200K reconstructed charm decays.

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INTRODUCTION

E791 is the fourth in a series of charm particle experiments performed at Fermilab's Tagged Photon Lab (TPL) over the past several years. The charm sample is produced through 500 GeV/c π^-N interactions in a platinum-diamond target. The data is recorded with a low bias transverse energy trigger (E_T) formed in the hadron and electromagnetic calorimeters. The goal is to reconstruct over 100K charm decays for high statistics studies and a for a close look at rare charm decay physics. As in the past, E791 uses a high precision silicon vertex detector and a large open geometry spectrometer to extract charm decays on low backgrounds.

The success of the E791 hinges on its high data rate capability and offline reconstruction of data. A high rate data acquisition system was built¹ to record a multi-billion event data sample necessary for extracting charm with such high statistics. The challenge ahead is the offline reconstruction of this very large event sample. Computing costs are dropping at a rate of about a factor of two each year, facilitating the timely processing of this large data sample.

SPECTROMETER

The spectrometer features 23 planes of silicon microstrip detectors covering a ± 100 mrad solid angle in the forward direction. The magnetic spectrometer consists of two horizontally bending dipoles with a combined p_T kick of about .5 GeV/c. 35 planes of drift chambers are interleaved throughout for charged particle tracking. Typical momentum resolutions for high mass charm states are in the 8-12 MeV/c² range depending on the decay multiplicity and decay energy available.

The target consisted of a series of foils, first .5 mm Pt foil followed by four 1.5 mm C foils, each spaced 1.5 cm apart. This arrangement

optimizes the detection of short lived states decaying in the air gaps between foils and provides sufficient interaction rate for the experiment. The target represents about .03 interaction length and produces about a 40 KHz interaction rate during our beam spill.

The beam particles are tracked into the target by a set of 8 upstream MWPC's positioned in the beamline and 6 planes of silicon microstrips (SMDs) located just upstream of the target assembly. The beam tracking allows a precise transverse beam location ($7\mu m$), while the z position of the interaction point can be easily isolated in a target foil. We use this beam constraint in locating the primary vertex interaction point with high efficiency.

Particle identification is provided by two multi-cell threshold Cherenkov counters², giving π/K separation in the 6-72 GeV/c momentum range. An electromagnetic and hadron calorimeter^{3,4} provide good e/π separation, as well as photon identification. Muons are tagged in a pair of hodoscopes following steel absorber at the downstream end of the spectrometer.

DATA SAMPLE

E791 recorded data with a loose transverse energy trigger (E_T) and beam track requirement. The E_T triggered event rate was about 9000 events/sec. E791's high rate data acquisition system, capable of logging 10 MB/sec., recorded about 4000 events each second during spill and interspill. These events were written to 8mm tape. 24000 data tapes were recorded in the 6 month running period, corresponding to 20 billion events.

COMPUTING

With such a large data sample, computing becomes a major issue. We have so far implemented two large RISC based computing farms at the University of Mississippi and

Ohio State University for reconstruction of E791 data. Each of these farms is equivalent to about 900 and 1500 MIPs respectively, with plans for future expansions.

These startup farms went into action in February 1992, just a month after the fixed target run had ended. At that time, using a preliminary version of our reconstruction code, we extracted our first charm signals.^{5,6}

Future farm activity is planned at Fermilab on the large IBM and Silicon Graphics systems set up at their computing center. In addition, the CBPF group is adapting a set of ACPII processors at FNAL for E791 use, in a joint FNAL-CBPF effort. In all E791 will have over 7000 MIPs of dedicated computing contributing to the 1-2 year reconstruction effort.

CHARM PHYSICS

The physics potential from E791 is enormous. It is the highest statistics charm experiment done to date. We will be able to improve the lifetime measurements of D -mesons to an unprecedented accuracy and make substantial improvements to charm baryon lifetime measurements. Our high statistics D -meson samples can be used to search for D^0 - \bar{D}^0 mixing, singly and doubly Cabibbo suppressed decays as $D^+ \rightarrow K^+\pi^+\pi^-$, and $D^0 \rightarrow K^+\pi^-$. We will be able to make major contributions to charm semileptonic decays, especially in the Cabibbo suppressed decays as $D^0 \rightarrow \pi^-l^+\nu$. Searches for flavor changing neutral currents, $D^+ \rightarrow \pi^+\mu^+\mu^-$, and for CP violation in D decays, such as in $D^0 \rightarrow K^+K^-$, may be made. E791's good efficiency for detecting Λ , Ξ , and K_s vee decays will give us high sensitivity to many rare charm baryon decay channels.

Thus far our efforts have been focused on optimization of reconstruction code and surveys of the such charm decay modes as $D \rightarrow K\pi$, $K2\pi$, and $K3\pi$ decays. For these studies, a vertex separation cut corresponding to

6-8 σ_z is made between primary and secondary charm vertex. We require that the charm decay points back to the primary or there be transverse momentum balance about the D -meson line of flight. Charm signals in these decay modes look very promising and are displayed in Figure 1. We presently estimate a reconstructed charm yield of over 200K events into these modes.

CONCLUSION

E791 has reached a milestone in recording a data set with more than 200K fully reconstructable charm decays. We are improving our code and will begin a physics pass on the data soon. We are looking forward to the start of our charm physics analyses.

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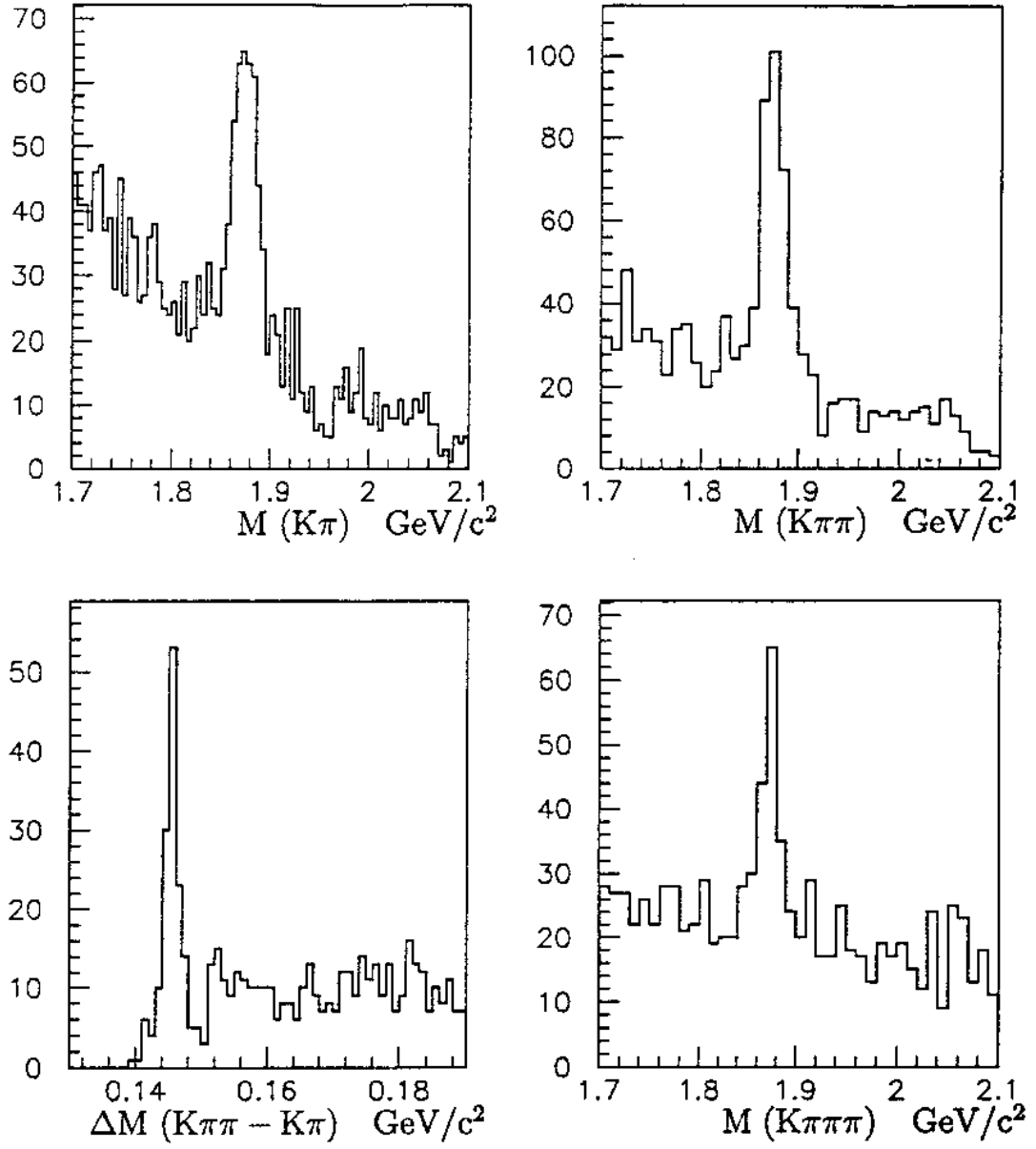


Figure 1. Charm signals extracted from a small fraction of the E791 data set.